Chapter 15:

15.1 : principle of linear Mom & impulse

- This method is used when you have Forces, velocities, time.

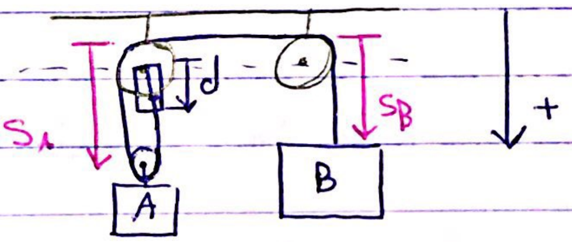
→ Forces should be external

Ex: 15-19

As you see in the Question it asked for the velocity after 2s (Time is Given)

$W_A = 10\ Ib$

$W_B = 50\ Ib$

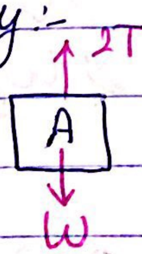


$L = S_A + S_A - d + S_B$

$L = 2S_A + S_B$

So $0 = 2V_A + V_B$ → eq 1

Now, you can use principle of linear momentum for Each Body:-



For A:- $\Sigma F = W - 2T$

$V_1 = 0$ (since it started from rest)

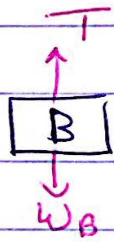
$mV_{A_1} = 0$

$mV_{A_2} = ??$

So: $\cancel{mV_{A_1}}^{\,0} + \int_0^2 \Sigma F \, dt = mV_{A_2}$

$\int_0^2 W_A - 2T \, dt = m_A V_{A_2} \longrightarrow$ eq 2

for B:



eq 3 $\longleftarrow \int_0^2 W_B - T \, dt = m_B V_{B_2}$

You solve $\underline{2}$ with $\underline{3}$ using 1

From eq 1

$2(W_A - 2T) = m_A V_{A_2}$

$2(W_B - T) = m_B(-2V_{A_2})$ $\times 2$

$2W_A - \cancel{4T} = m_A V_{A_2}$ $-$

$4W_B - \cancel{4T} = -4 m_B V_{A_2}$

$2W_A - 4W_B = m_A V_{A_2} + 4 m_B V_{A_2}$

$$2 \times 10 - 4 \times 50 = \left[\frac{10}{32.2} + (4) \times \frac{50}{32.2} \right] V_{A2}$$

$$-180 = 6.52 \cdot V_{A2}$$

$$V_{A2} = -27.6 = 27.6 \uparrow$$

So $V_{B_2} = 55.2 \downarrow$

15.3: Conservation of linear Momentum + Impact

$$mV_1 = mV_2$$

happens When ΣF external is zero.

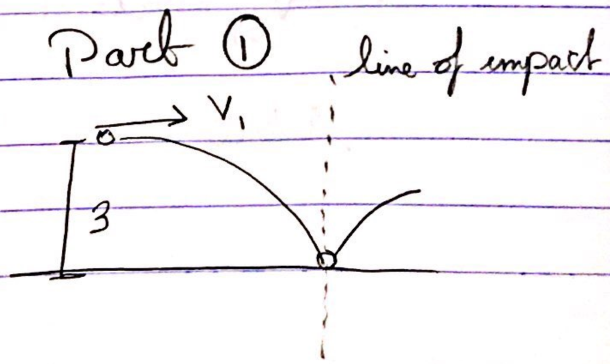
- → Collision : You have to define l. of impact
- → Movement With NO friction
- → projectiles

Ex 15-68, projectile + collision

$e = 0.8$

This is used for V_y (line of impact)

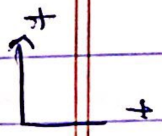
Part ①



So:-

V_g, Velocity of Ground

$$e = \frac{V'_{by} - \cancel{V'_{gy}}^{\,0}}{\cancel{V_{gy}}_{\,0} - V_{by}}$$



$$-0.8\,V_{by} = V'_{by} \leftarrow \text{بعد التصادم}$$

و قبل التصادم بلحظة
يلي ابدي اخذها

$$V_{by}^2 = \cancel{V_{by_0}^2}^{\,0} + 2a\Delta y$$

$$V_{by}^2 = (2)(32.2)(3)$$

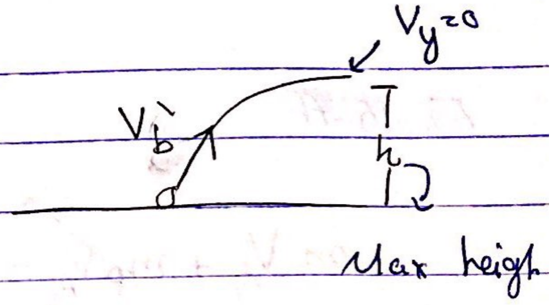
$$\boxed{V_{by} = 13.9} \downarrow$$

So : $-(0.8)(-13.9) = V'_{by}$

$$\boxed{V'_{by} = 11.1} \uparrow$$

V_{bx} is constant $= 8$ ft/s

Now Part 2:



$$V'^2_{by} = \cancel{V_y^2}^{\,0} + 2a\Delta y$$

$$123.648 = -2 \times 32.2 \times h$$

$$h = 1.92 \text{ ft}$$

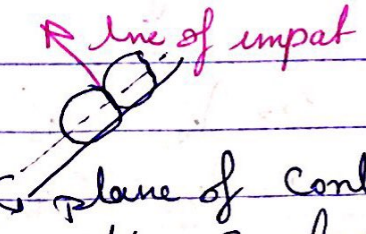
Note: collision has 3 cases

$e=0$: particles stick together after collision

$e=1$: No loss in Energy

$0<e<1$: Normal collision (loses in Energy)

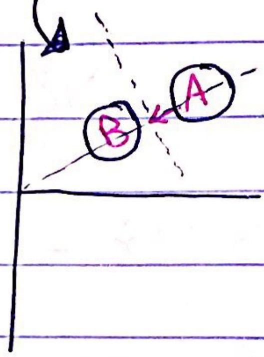
- e is always used for velocities related to line of impact and the other velocities are conserved.



Ex: usually line of impact is the Normal to the Surfac

Central impact

Ex: 15-77



$$m_A V_{A_1} + \cancel{m_B} \cancel{V_{B_1}}^{0} = m_A V_{A_2} + m_B V_{B_2}$$

Since masses are equal:-

$$5 = V_{A_2} + V_{B_2} \quad \text{—} (1) \qquad \swarrow +$$

Using e;

$$e = \frac{V_{A_2} - V_{B_2}}{V_{B_1} - V_{A_1}}$$

$$0.8 = \frac{V_{A_2} - V_{B_2}}{0 - 5}$$

$$-4 = V_{A_2} - V_{B_2} \quad \text{—} (2)$$

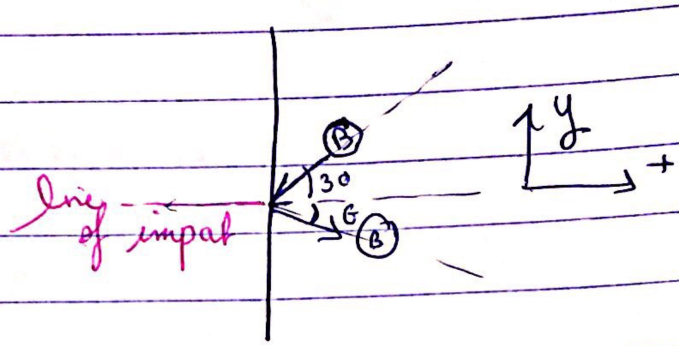
solving.

$$5 = V_{A_2} + \cancel{V_{B_2}}$$
$$-4 = V_{A_2} - \cancel{V_{B_2}} \quad +$$

$$1 = 2V_{A_2}$$

$$\boxed{V_{A_2} = 0.5} \longrightarrow V_{B_2} = 4.5 \qquad \swarrow +$$

oblique impact



$$e = \frac{V_B' \cos\theta}{0 - V_{B_2} \cos 30^\circ}$$

wall

$0.6\ (V_{B_2} \cos 30^\circ) = V_B' \cos\theta$

$2.34 = V_B' \cos\theta \rightarrow ①$

$+V_{B_2} \sin 30 = + V_B' \sin\theta$

$2.25 = V_B' \sin\theta$ — ②

Divide ② by ①

$\theta = 43.88$

$V_B' = 3.24$

Scanned with CamScanner

* Angular Momentum

- $H = \vec{r} \times m\vec{V}$ ← used when asked to find Angular Momentum

- Also, $\Sigma M_o = \dot{H}_o$

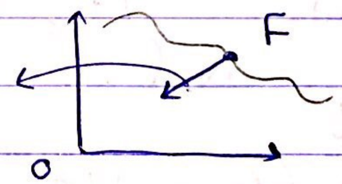
مشتقة الـ Momentum بالنسبة للزمن

- And so: $H_{o_1} + \Sigma \int_{t_1}^{t_2} M_o \, dt = H_{o_2}$

used when you are Given forces and Moments

- Conservation: $(H_o)_1 = (H_o)_2$

• This Force does no Moment.



• Parallel forces to axis does no Moment around the axis.

Ex:- 15-102:

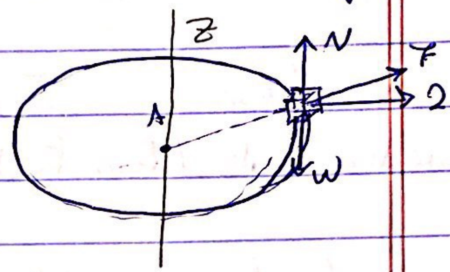
- In this Question There are 4 forces

$F_1 = 2\,Ib$

$F_2 = 7\,Ib$

$F_3 = W$

$F_4 = N$



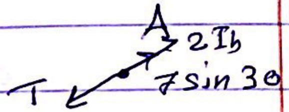
Take H around Z axis:-

- N, W Does no Moment around it
- 2 Ib Can't too
- The only force affecting is 7 cos 30

Now: $\underbrace{H_{o_z}}_{\text{rest}}{}^{\to 0} + \int_{t_1}^{t_2} \Sigma M\, dt = H_{1z}$

① ← $\int_0^t (7\cos 30)(4)\, dt = \overset{4}{r} \times m V_1$ ← You have to find it

→ To find V_1, use Newton's law



Use ΣF_n:-

30° → $T - 2 - 7\sin 30 = \left(\frac{10}{32.2}\right)\frac{V^2}{4}$.

$V = 17.76$ put in ① : $t = 0.91$ s